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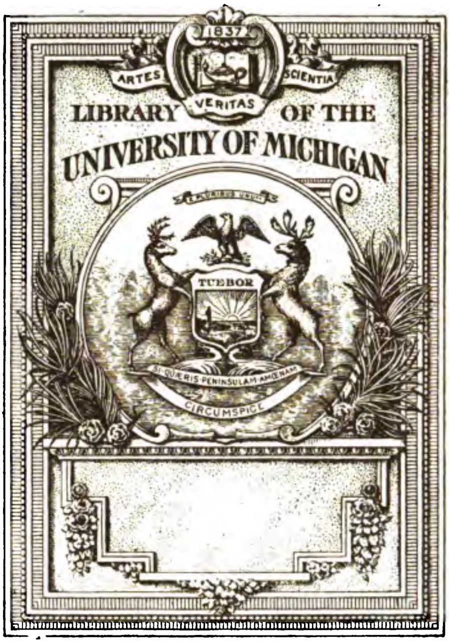

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REPORT OF THE COMMITTEE

OF THE

Citizens' Association of Chicago.

ON THE

Main Drainage and Water Supply

OF CHICAGO.

SEPTEMBER, 1885.

CHICAGO:
Rooms, 85 Merchants' Building.
1885.

Citizens' Association of Chicago.

ESTABLISHED 1874.

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REPORT OF THE COMMITTEE

—ON—

MAIN DRAINAGE AND WATER SUPPLY.

CHICAGO, Aug. 27, 1885.

To the Executive Committee of the Citizens' Association:

The undersigned committee appointed for the purpose of investigating the subject of Main Drainage and Water Supply of Chicago, begs leave to submit the following report:

A problem of the first magnitude is presented in the main drainage of a city of 700,000 inhabitants with the immediate prospect of a population of 1,000,000, and a growth of 2,000,000 within the life-time of citizens who knew Chicago as an Indian trading-post. That the city should have attained this growth without the development of an adequate official plan, for a permanent system of main drainage would be startling in this day of sanitary science, were it evident that the conditions of the problem had ever been properly apprehended. The sanitary history of Chicago is a history of makeshifts and expedients, in which official prevision has scarcely ventured beyond corporate limits to the consideration of the drainage basin of which the municipal area is but a small fraction. Even those expedients which, while involving a moderate expenditure for the relief of the present situation, might still be in harmony with a general plan, seem to be inadequately realized, or quite misapprehended.

Chicago, in regard to her water supply and main drainage, is perhaps, more fortunately situated than any other of the principal cities of the country, except those on our large, rapidly-flowing rivers, which carry away the sewage at once, a condition which may here be readily duplicated. Cities on tide-water or minor streams, with much less population and having problems of greater difficulty to deal with, have not hesitated to make far greater expenditure, in proportion to their resources, than

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is required here for measures of permanent relief. They have considered it wise, before the public health was menaced, to call in the most eminent experts to consider the problem, with a view to the best solution that the conditions permitted. They have even regarded large expenditure in the collection of data and in exhaustive preliminary study as a measure of undoubted wisdom.

Your committee has been able to give to the subject only a few weeks of special observation and study. Its sources of information are accessible to any citizen who chooses to investigate the matter for himself. Cognizant of the facts of our sanitary history, it is a matter of no great difficulty to define present abuses, to point out measures of relief and to suggest a general plan for the permanent solution of our drainage problem, as a matter for popular discussion and expert consideration.

POLLUTION OF THE WATER SUPPLY.

In the great rain of August 2 of this year, the contents of both branches of the Chicago river, with the sewage accumulation of many weeks in the South fork, the contents of slips, and the flushings from several hundred miles of low-grade sewers, were, in a few hours, incontinently belched into the lake. At every considerable freshet in the Desplaines and in the North branch, or several times in an average season, a similar obnoxious flood, differing little in degree, is turned lakeward. At other times the flow from the Desplaines is quite sufficient to supply the canal, and the South branch is left in a stagnant condition of accumulating putridity, ready to take its way to the lake on slight occasion. Your committee found the South branch in bad condition a week after the great storm, and within ten days the South fork was pestilential—a seething, bubbling mass of decomposition, exhaling the most noisome odors.

The ejection of such volumes of sewage into the lake at irregular intervals, is a matter for most serious consideration in connection with the water supply. That it sometimes reaches the crib under favoring conditions of wind and current is a matter of direct observation and evidence from city hydrants. That it sometimes extends southward to the Hyde Park supply is also ascertained. Even the comparatively small discharge from the Fullerton avenue conduit has given evidence of pollution when no other sewage was entering the lake. Recently the discharge from this conduit was observed in an unbroken stream for over a mile south and parallel to shore, and again in a similar position to the north, to the well-grounded alarm of the people of Lake View. That raw, unoxidized sewage occasionally and not rarely contaminates our drinking-water, does not admit of serious question. [See note *a*.]

If we suppose the entire sewage of Chicago for one week—and such accumulation is sometimes greatly exceeded—to be turned into the lake at the mouth of our harbor and uniformly distributed through the water for four miles into the lake and eight miles along the shore, each 200 gallons of water would contain one gallon of sewage. Sanitary authorities variously estimate the dilution required to oxidize sewage beyond offense at twenty to one hundred times. As this oxidation requires time, no argument is needed to make it apparent that, in the general diffusion of the contents of our river through the body of water off-shore, partially oxidized sewage reaches the crib. Even though we admit the complete oxidation and diffusion of sewage through the waters off this shore, sanitary science would hardly commend the domestic use of oxidized sewage, nor will the average citizen feel reassured at the admixture of a half-gallon thereof in his daily water supply. [See microscopical and chemical examinations in Supplementary Report, pp. 22–32.]

The tendency, however, of streams of different specific gravity and constitution is to remain isolated, or to diffuse slowly, as may be observed where any stream debouches into a body of water, or where two rivers unite. For this reason a large sewage discharge may remain off our shores unoxidized for a much longer period than if we could suppose it rapidly and generally diffused. The danger from sewage contamination would thereby be greatly increased and of oxidized sewage in no wise lessened.

While the occasional admixture from sewage is beyond dispute, and the presence of oxidized sewage is probably far more frequent, the determination of any well-defined current that may prevail in the lake off our shores would be a matter of great in-

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[a] On Wednesday, August 5, the river discharge was observed in an unbroken stream to and around the crib. Chemical and microscopical examinations of the water, collected under different conditions, are appended to the Supplementary Report.

terest. So far as the observations of your committee extend, they go to show that the surface current is most largely a matter of direction of wind, and is accompanied by a counter-current near the bottom; so that with a stratum of sewage-water beneath, mere surface observation is not sufficient to determine the direction or extent of its movement.

It is obvious that, if sewage is allowed to debouch into the lake at all, freedom from risk of contaminating our water supply can only be secured at great expense—far greater than would be required to permanently dispose of the sewage in some other direction.

THE NORTH BRANCH AND FULLERTON AVENUE CONDUIT.

The operation of the conduit has maintained this branch in fair condition. Ordinarily, in pumping from the lake, the contents pass down into the South branch and thence into the canal. If the South branch is stagnated by the Ogden-Wentworth ditch discharge, then it goes to the lake; as it does also at the time of a freshet in the North branch. After the late rise had somewhat subsided, the pumps were set in operation and the flow through the conduit was reversed in the direction of the lake at a time when the river above was discharging one-half the capacity of the conduit. The tendency was to stagnate the North branch instead of aiding the natural flow to cleanse it, besides discharging the sewage at a more objectionable point in the lake. Your committee is strong in the opinion that the conduit should never be operated except in a direction from the lake to the river, and at times of flood-discharge it should be stopped.

The North branch drains an area of some one hundred and thirty square miles, and its flood-discharge complicates the proper handling of the city's sewage. It is believed that it would be wise to divert this stream to the lake from the vicinity of Bowmanville. Flushing-gates could control the discharge into the old stream, and a proper wheel would supply a return current from the lake through the new cut when the natural supply was deficient. That part of the stream north of the present pumping station, and which is rapidly developing dockage facilities, would thus be cleansed as well as the entire stream below. The use of the Fullerton avenue conduit for its present purpose being thus rendered unnecessary, the conduit could be farther extended into the lake for water-supply purposes, and branch tunnels run therefrom to supply the western and northern districts of the city and the towns of Lake View and Jefferson. Its capacity would be ample for many years to come, and no cheaper or better way suggests itself of tripling our water supply and at the same time taking an important step in the solution of the sanitary problem. The fact that the limit of our present supply is closely approached at times, calls urgently for additional provision at an early day.

THE SOUTH BRANCH AND THE BRIDGEPORT PUMPING STATION.

The condition of the South branch is dependent on the operation of the Bridgeport pumping station, and on the discharge from the Desplaines through the Ogden-Wentworth ditch. With little water from the Desplaines, six pumps, the usual number in operation, are able to keep the South branch in tolerable condition. They furnish to the canal about what would go down it by natural flow at the present lake-level if the canal were properly cleaned out. Practically, the entire discharge of the Desplaines water-shed north of Summit comes through the west fork when the Desplaines has fallen to the capacity of six pumps, for at that stage the Desplaines is entirely diverted through the Ogden-Wentworth ditch to Bridgeport. At high water it is believed that over half the flood discharge comes through the Mud lake valley. To the extent of the supply from the Desplaines is the Bridgeport pumping station ineffective, and to estimate this supply at an average of one-third of that pumped into the canal is probably within limits. In other words, if the Desplaines were shut out of the Mud lake valley the flushing of the South branch into the lake, or its stagnation, would be entirely prevented and its ordinary condition improved fifty per cent.

For a few days after the great rain of Aug. 2, only Desplaines water was thrown into the canal, and this was so evident that the

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b. The Bridgeport pumping works, from August 1 to 19 inclusive, were operated 14 days; 6 pumps 9 days, or 54 days of 1 pump; 8 pumps 5 days, or 40 days of 1 pump. Laurel Hill coal consumed, 384 tons, or 4.085 tons per pump per day; 32.68 tons per day for 8 pumps, 45.39 pounds per minute to raise 54,000 cubic feet of water 20 inches, being 12,290,000-foot-pounds of effective duty per hundred pounds of coal. This is only a little over one-fourth the requirements of the contract.

pumps were finally stopped and the canal supplied by natural flow. Meantime, with the diminishing supply from the Desplaines, the flow of the South branch toward the lake was arrested until it became stagnant and very offensive. On August 14th, the entire plant of eight pumps was put in operation, throwing about fifty thousand cubic feet per minute down the canal. This raised the surface twenty inches above the lake level and produced a maximum current of one and one-half miles per hour. Notwithstanding this velocity boatmen reported that the difficulty of navigation was in no wise increased, as the additional depth of waterway was full compensation for the increased velocity of current. One steam canalboat, with two boats in tow, was observed making headway up the canal at the rate of two miles per hour, and a horse boat at one and one-half miles. The canal superintendent reported that they could stand another foot with ease, or a large increase beyond the capacity of this plant. Your committee, therefore, concludes that the reported objection to an excessive supply in the canal is without foundation, and does not doubt that, with the canal in proper condition, 75,000 cubic feet per minute could be pumped without injury to navigation, that being a problem of waterway rather than of current. This quantity would be about two and a half times that ordinarily furnished by the Bridgeport plant, and, with the Desplaines properly restrained, would maintain a fair sanitary condition in the South branch until permanent measures of relief can be carried out.

It is foreign to the purpose of this report to review the Bridgeport pumping works. Suffice it to say that, although they have been several times altered by their builders, they yet fail to attain the specified capacity and duty, and further alteration is understood to be contemplated. If they were the best of their type there would be no difficulty in urging them to supply all the canal could be made to take. It may be doubted, in view of the experience in Holland, or even with the old Bridgeport wheels, whether the best centrifugals are as efficient as lift-wheels when the level of supply is tolerably constant. Such wheels could have been placed for half the cost of the present plant, and they would undoubtedly be superior for the conditions obtaining at Bridgeport, in view of the debris which it is necessary to screen from the centrifugals. On a recent visit it was found that in order to obtain an effective head of twenty inches, an additional head fully as great was wasted.

THE SOUTH FORK.

That this branch has been allowed to continue, from year to year, in an abominable condition of filth beyond the power of pen to describe, is one of the anomalies of our municipal history. Flushed only during periods of heavy rainfall, its contents inevitably find their way to the lake. Its highly offensive condition is most largely due to the extensive packing establishments, and the industries incidental thereto. As this is a special class of sewage, it would be fair to demand chemical precipitation, or other treatment equally effective, thus removing at once a large, and the worst, proportion of putrescible matter. Measures of permanent relief should be instituted at an early day. Several plans for regularly voiding the contents of this fork can be suggested. One of the best would seem to be a pumping station and a conduit on 39th street to Lake avenue, on Lake avenue to 56th street, and along 56th street to the lake, thus furnishing a proper outfall toward the South fork for the sewerage of the northern portion of Hyde Park, which is naturally tributary to the Chicago district. The opening of a navigable channel along 39th street is also worthy of consideration; a channel that may be demanded in the interest of permanent bridges in the heart of the city, and also by the requirements of commerce in the southwest district whenever the National government may have developed ample water communication to our Western rivers. Incidentally, it may be said that the main sewers on 12th, 22d, and 35th streets, which now discharge into the lake, should ultimately have their outfall at the river—the natural elevation being sufficient for that purpose—and that no new outfalls on the lake front should be contemplated in the future.

The west arm of the South fork is the natural outfall of a large portion of the town of Lake, south to 60th street. Unless it is filled up or farther extended through to the canal, at an early day, its proper cleansing will present a serious problem. Meantime, to drain into it the surface water naturally tributary thereto, and which has been diverted to the canal, would at times afford some relief.

Your committee would also suggest that many slips are frequently in such condition as to demand some provision for properly circulating the water therein or changing their contents.

THE OGDEN-WENTWORTH DITCH.

The history of this cut makes it difficult to believe that the conditions affecting our main drainage have been properly appreciated by the municipal authorities.

The Mud lake valley has always been the natural outlet for a considerable proportion of the flood-waters of the Desplaines. In the summer of 1871, a ditch was opened through to the Desplaines by private parties without even a protest by the city authorities; but during the summer of 1872 a stone dam was constructed across the ditch, to be soon after removed by parties interested in an open ditch. Low brush dams were constructed at the head of the ditch in the fall of 1874, of 1875, and again in 1876, and as many times washed out. In the winter of 1876–7, a more permanent structure was constructed, which was effective at intervals, but finally destroyed for all practical purposes in the spring of 1882. Since then, at the approach of winter, the ice interests on the Desplaines have constructed dams of sufficient height to retain the winter flow in its natural channel. Only one attempt has been made, and that by the canal authorities, to restrain the entire flood discharge, and this resulted in failure. The purpose of the city authorities has been only to restrain water to the bank height, and their efforts have been effective for about three years only out of thirteen. For ten years at least the ordinary flow of the Desplaines, from a water-shed of many hundred square miles, has come to Chicago to complicate her main drainage and render the canal ineffective, and with each year a larger proportion of flood-waters find their outlet in this direction, threatening a complete diversion at an early day, unless remedial measures are adopted.

When your committee visited the head of this ditch, after the great rain, it was taking nearly the entire discharge of the Desplaines river, or an amount equal to the capacity of the pumps. A very small expenditure at that time would have restrained this water in its natural course, and enabled the pumps to work on the South branch, which had become very offensive. This work was not done, and an intolerable condition was prolonged for a full week. The permanent closing of the Ogden-Wentworth ditch to natural bank height need not cost the expense of running the pumping works for one month, or but a fraction of the yearly expense of handling Desplaines river water. [See note *c.*]

FLOOD DANGERS.

The treatment of the flood discharge is a far more difficult matter, but a question of much moment, aside from its relations to our sanitary problem. Old citizens will remember the great flood of 1849, and the destruction produced thereby, a flood that is liable to recur under exaggerated conditions with unlimited capacity for mischief.

The Desplaines water-shed has been largely cleared up and water-courses opened, so that floods come more suddenly and in greater volume than in former years. There is liable to be an accumulation of from twelve to eighteen inches of water in the form of snow over this area, to be quickly melted by a warm rain, in a manner similar to the great Ohio river flood of 1882. If this be accompanied by an ice gorge in " Twelve-mile level," below Summit, as would be probable, this great flood would be precipitated through Chicago in untold damage. With no ice gorge, the result would be sufficiently disastrous.

It is unwise to argue that such danger is remote. All the conditions except the usual temperature and rainfall were fully satisfied in 1881. Fortunately, with an average temperature of 34 degrees, and a rainfall of only one-half inch during a period of twenty-one days, this great body of snow was gradually melted, not, however, without a long-continued large flood volume, attended with considerable damage. It is hardly supposable that nature would be again so considerate. [See note *d.*]

The necessary combination of circumstances has occurred too often at other localities to warrant the belief that Chicago will

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c. The bed of the Ogden-Wentworth ditch at its head is about six feet below the top of Summit and Cook's rock fords and the rock bed of the Desplaines river, commencing opposite the quarries of the Illinois Stone Company above Lemont, so that all the flow of the Desplaines below this elevation is thus diverted toward Chicago.

d. The water in the form of snow on the ground, in the spring of 1881, was twelve inches, or a fraction less than the average winter precipitation. The average precipitation or rainfall for the month of April, during which this melted and ran off, is 3.24 inches, and the maximum, 6.12 inches, so that a rainfall of only one-half inch during the time is phenomenal.

be indefinitely exempt, and she is built above no protecting bluff escarpment. [See note *e*.]

SUGGESTIONS FOR A PERMANENT SOLUTION.

Your committee has incidentally brought to light facts bearing on a solution of the drainage problem, which would appear to have been hitherto unconsidered. They are stated as suggestions to, and in argument for, a body of experts, which should be constituted without delay, to adequately consider the whole subject in full detail.

The general problem as it appears to your committee may be stated as follows:

1. By keeping the sewage out of the lake, Chicago can avoid a nuisance on her shores and save, in future changes and extensions of her water-supply system, a large part if not the whole of the cost of an adequate main drainage.

2. Experience has not yet developed any artificial treatment of sewage that does not involve a large first-cost and continual expenditure. The best of these, by the method of intermittent downward filtration, is not feasible for Chicago, on account of the great distance to proper land. Even were all the conditions properly fulfilled, some means would still be required for circulating the water in our rivers. In the impossibility of disposing of the sewage quickly, by natural flow, and at far less cost, any plan of sewage treatment may be dismissed from present consideration.

3. The proper disposal of the sewage is unquestionably down the valley of the Illinois. It must be diluted to that point which will speedily produce complete oxidation, or the growing populations along the river will not permanently tolerate so insufferable a nuisance.

4. The contents of all channelways, into which sewage is discharged, should be changed so rapidly that no sewage will remain within the city limits over twenty-four hours.

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e. An ice gorge at Willow Springs could readily raise flood-height to 20 feet above datum. The flood of 1881 rose to 16 feet above datum, and came very nearly to the top of the railway embankments across Mud-lake valley. If these should be overtopped they would rapidly give way and precipitate the flood on the low-lying districts to great depths. Water might even find its way to the lake via Storey's mansion on Grand boulevard, the surface there being at an elevation of only 15 feet.

5. The drainage area, now tributary to the sewerage district, should be reduced as much as possible in order to avoid the variations of rainfall over large outlying districts, the danger of floods, and the liability of an occasional discharge of the contents of our channelways into the lake. The main drainage of Chicago involves the entire water-sheds of the Desplaines above Summit and of the North branch, and the region south to the general east-and west line of 60th street; an area of nearly one thousand square miles. It has already been suggested that the North branch can be readily diverted to the lake from Bowmanville, thus reducing the area by over on ehundred and twenty square miles.

An examination of the Desplaines river shows far greater capacity for many miles above Summit than below; in fact, for twelve miles below Summit the bed is a succession of pools, with rock bars, differing little in height, and retaining the water at a uniform level of about eight feet above Chicago datum. With a mile of bank only three to four feet above low water, and broken by frequent crevasses of one and a half feet opening out into the rapid descent of Mud lake valley, it must be evident that a large proportion of all flood-waters, above a certain minimum discharge, find their way to the lake. The entire flood discharge of the Desplaines can, without doubt, be readily confined in a course to the south, but this is a course which it has never pursued, and such diversion of its natural flow would render the city liable for any resulting damages. Unquestionably the channel could be greatly improved so as to diminish this liability, and this might be expedient did not a better solution offer.

From an examination of the divide between the Desplaines and the North branch, it is found feasible, at moderate expense, to divert the Desplaines near the south line of the town of Maine into the North branch at its westerly bend; thence following the North branch valley to Bowmanville and to the lake through Lake View. [See note *f*.]

This diversion would dispose of from 75 to 80 per cent. of all the flood-waters of the Desplaines gathered from the water-shed

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[f] **The idea of diverting the Desplaines to the lake was suggested by Mr. O. Guthrie in February last.**

above Summit, besides the flood waters of the North branch as previously suggested. There will remain about 100 square miles, which may be called the Chicago sewerage district proper, and about 160 of the Desplaines, or 260, in place of about 1,000 square miles, to consider in a scheme of main drainage.

Assuming that an increased capacity of the canal is conceded as an essential in any scheme, your committee offers the suggestion that such enlargement be confined to the first eight miles, or to a point near Summit, at which the canal and the Desplaines are within less than a quarter of a mile of each other, and where they may be readily connected. A full consideration might show that from Bridgeport to Summit, the West fork and Ogden-Wentworth ditch route, would possess superior advantages. [See note *g*.]

For twelve miles below Summit, or until we reach Walker's quarry above Lemont, the water stands on a level about eight feet above datum, or less than five feet above present lake level. Throughout this reach there is much channel of twelve feet in depth and of ample width, and much more that would undoubtedly cut out to that depth under the influence of a brisk current. For only a small portion of this distance were rocky fords found, and it is believed that a full examination would not disclose a serious amount of rock excavation; so that a channel may be produced here seven feet below present lake level, and not less than two hundred feet wide, for twelve miles, at comparatively small expense. For eight miles below Walker's quarry the channel would be practically in continuous rock-cut, the average declivity of this portion of the valley being about one foot per mile. Near Lockport it falls off rapidly to twenty feet below datum. It would seem from the examination thus far made that a channel of sufficient capacity can be made on this route for about one-half the cost of enlarging the canal, and this channel would be capable of future enlargement at moderate cost. This route can only be considered, however, in connection

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g. The enlargement of the canal to Summit to any required capacity can be effected at little or no cost on account of the value of the clay to brick-makers. From Summit to one mile above Lemont, a smaller proportion of work would be required in the river as compared with the canal. From Lemont south is largely rock cut, and the most feasible route in the valley may be followed, returning in part to the existing canal line if deemed expedient.

with the diversion of the flood-waters of the upper river. [See note *h*].

The duty of the new channel would be to take care of the natural flow of 260 square miles of territory and the sewage, properly diluted, of its population. It can be developed with ease into a great navigable channel, and furnish an ample water supply for the low-water navigation of the lower river from the most magnificent reservoir available as an aid to navigation, and make apparent the error of the opinion which led to the construction of locks and dams on the Illinois, below Peru. In an ample section, with all the depth and grade which could be given to a channel from Chicago to Joliet, the stream would be readily navigable, as experience has shown with much higher velocities on our Western and Southern rivers. If the project should ever be carried out with due regard to its possibilities as an aid to navigation, over one hundred thousand horse-power would be available between Lockport and Peru, the yearly value of which would represent a dividend on many millions of dollars.

The suggestion proposed has the merit of inviting expenditure for present relief in the direction of an ultimate plan, each step of which would be of substantial benefit. Thus, in a very few years, without the necessity of an increased indebtedness, a permanent plan may be carried out at a relatively small expense as compared to that of many of our cities. At the same time an important step would be taken in a proper project for connecting the navigation of the Great Lakes with that of the Mississippi river, which may be followed by the General government without suspicion that it is purely in the interest of a local drainage project.

The solution of our drainage problem involves contiguous territory, many diverse interests, and a mature expert consideration, after the most comprehensive data have been collected. It would be rash to urge any project as the best in advance of the competent study which should be provided for, but in calling your

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h. Your committee is aware that the Desplaines was considered, in 1865, as a possible drainage channel, and rejected in favor of the canal deepening. Had future requirements in an enlarged channelway been evident at that time, or had a plan of disposing of the flood-waters of the Desplaines suggested itself, it is believed that a different conclusion would have been reached.

attention to what appears to be a ready solution of the problem, it must be apparent that the matter has not hitherto been adequately considered.

Your committee would urge with all possible force the necessity of an expert commission to make the fullest investigation. The commission should be constituted for an ample period, and be sufficient in number to give competent expert consideration to all phases of the problem and to eliminate purely personal views. To suppose that those charged with executive duties in a great city will find the leisure to adequately consider the matter would be to ignore our past history.

RESUMÉ.

To sum up, the suggestions of the committee are as follows:

That the proper limits of the Chicago sewerage district are north to the line of Bowmanville, south to 60th street, and west to the Desplaines divide.

That all sewage whatsoever in this district should be diverted from the lake as an outfall.

That the flood waters of the Desplaines and the North branch should be diverted to the lake north of this district, or through Lake View township.

That a lift-wheel be placed at the junction of the proposed new cut through Lake View and the North branch to flush the latter stream when natural flow is deficient.

That the Fullerton avenue conduit, thus rendered unnecessary for the cleansing of the North branch, be farther extended into the lake and utilized for the purposes of additional water supply.

That the South fork be connected with the lake by a conduit. A navigable channel from the lake and an extension of its west arm to a junction with the canal is worthy of consideration, as providing for dockage-extensions in Mud lake valley, which a proper navigable channel to the west, may some day demand, and also, in connection with the Lake View cut to the North branch, obviate the chief objection to permanent bridges in the heart of the city.

That an ample channel be created to the Illinois river sufficient to carry away, in a highly diluted state, the sewage of a large population—the immediate obviously plan being by an enlargement of the canal from Bridgeport to Summit, its extension at that point to the bed of the Desplaines, and the improvement of the Desplaines as herein indicated, leaving the canal below Summit in its present condition.

That this channel may be enlarged by the State or National government to any requirement of navigation or water supply for the lower river, creating, incidentally, a great water-power in the Illinois valley.

That the general plan can be carried out step by step to the gradual improvement of the sanitary condition, and without creating a debt or requiring an extraordinary tax levy.

That a comprehensive plan, any portion of which may be carried into execution whenever the conditions make it necessary, and which will still dovetail into the general system, demands for its conception and elaboration the creation of an expert commission, to which the whole subject of the main drainage and water supply of Chicago should be at once committed for exhaustive study and report.

Respectfully submitted,

O. GUTHRIE,
L. E. COOLEY, C. E.,
F. W. REILLY, M. D.,
WM. RUTHERFORD,
CHAS. A. MACDONALD,
DAVID BRADLEY,
J. J. GLESSNER,
EDWIN LEE BROWN.

Committee.

Supplementary Report of the Committee.

CHICAGO, Sept. 12, 1885.

To the Executive Committee of the Citizens' Association:

GENTLEMEN:—In accordance with the promise in our report of the 27th of August, there is herewith submitted the conclusions of Mr. B. W. Thomas and of Prof. Delafontaine, on the purity of the water supply of Chicago, the former based upon many hundred microscopical examinations, the latter upon one hundred and thirty chemical analyses. The investigations of these accomplished experts cover a long period of time and embrace the character of the water actually supplied to our citizens for consumption under all the varying conditions which affect its purity.

This testimony amply confirms the belief that the source of the Chicago water supply, Lake Michigan, in its natural condition, is such as should satisfy the most captious, and that no alarm need be felt for the ultimate satisfactory solution of the water question, except through neglect or incapacity. Your committee is, however, unanimous and unqualified in stating that, under existing circumstances, the water supply is frequently and for considerable periods of time, dangerously contaminated. That the river water and sewage have, on several different occasions since the second day of August last, reached the crib in an unbroken flow, admits of no possible doubt. River water and sewage in a partially diluted state have surrounded the crib during nearly the entire time covered by the investigations of your committee.

Accompanying this report is a sketch-map illustrating the

NOTE.—The reports here submitted were drafted by a sub-committee, consisting of Messrs. GUTHRIE, COOLEY and REILLY. To Mr. GUTHRIE especial acknowledgment is due—his large personal experience and knowledge of the conditions having contributed materially to the mass of details collected in the brief time at the disposal of the committee.

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principal suggestions of the committee, contained in the report of August 27th, and which, with the explanatory text, presents the subject in graphic form.

Respectfully submitted,

O. GUTHRIE,
L. E. COOLEY, C. E.,
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EDWIN LEE BROWN,
Committee.

EXPLANATION OF SKETCH MAP.

It is proposed to divert the North branch of the Chicago river from the vicinity of Bowmanville to the lake through the northern part of the town of Lake View. This will obviate the complication of flood-discharge, and, in dry weather, a lift-wheel at Bowmanville will furnish clean water from the lake to the North branch below that point. This diversion will do away with the use of the Fullerton avenue conduit for cleansing the North branch, and make the conduit at once available for water-supply to a large district of Chicago and adjacent suburbs. Incidentally the low prairie district of Evanston, Niles, and Jefferson will be greatly improved.

The proposed diversion of the flood-waters of the Desplaines river across the divide near Norwood Park, following the North branch and its diversion thence to the lake, will control the flood-discharge of the Desplaines for about seventy-five per cent. of its drainage-basin above Summit. The upper part of Salt creek may be also readily diverted by the same route. Thus all complication of floods from the Desplaines, which in part naturally follow the Mud lake route to Chicago, will be done away with.

These diversions place all the water-shed affecting Chicago under control so that sewage need not reach the lake, and will permit the use of the bed of the Desplaines below Summit for a main-drainage channel to the Illinois river. There remains only 160 square miles in the "Desplaines drainage district," and 100 square miles in the "Chicago sewerage district" to tax the channel to the Illinois. The "Chicago sewerage district" extends to the line of diversion on the north, to the Desplaines divide on the west, and to the natural divide in the towns of Hyde Park and Lake on the south. Evanston to the north, and Hyde Park and Lake to the south are naturally independent districts demanding individual treatment.

The proposed "Main-drainage route" follows the canal to Summit; or, if found preferable, the Ogden-Wentworth ditch, reversing its present direction of flow. Thence from Summit for twelve miles the bed of the Desplaines is found to require much less work than the enlargement of the present canal.

From the South fork a conduit is shown along 39th street and entering the lake at 56th street, thus intercepting the sewerage of the northern portion of Hyde Park. A navigable channel from the lake along 39th street is suggested as preferable in the interest of permanent bridges in the heart of the city, and also of the future development of a water route to the West.

The arrows on the map indicate the proposed direction of all flow, with the following exceptions: From the North branch to the lake the flow through the new channel would be lakeward for flood waters, and riverward for cleansing purposes during low-water stages. Along Ogden ditch the arrow indicates the present flow, which, it is suggested, may be reversed by widening and deepening, so as to create a current by gravity through the West fork from the South branch.

MICROSCOPICAL EXAMINATION OF THE CHICAGO WATER SUPPLY.

CHICAGO, September 10, 1885.

To the Citizens' Association of Chicago:

GENTLEMEN:—Thanking your committee for the opportunity of visiting the lake crib, and making personal examination of the source of the city water supply very soon after the late severe storm of rain and wind, I will, as requested, make a

brief statement of the general appearance of the lake at and around the crib at that time, and of some of the contents of the water from the city hydrants two days later.

July 30th, on invitation of Commissioner of Public Works, Dewitt C. Cregier, I had the pleasure of visiting the lake crib and the outlet, or what should be the inlet, of the Fullerton avenue conduit. For some time before this visit, the pumping works at Bridgeport had more than taken care of the water of the Desplaines river that comes through the broken dam and the Ogden-Wentworth ditch, and the Fullerton avenue conduit had been discharging from the lake into the river, and consequently the lake water was very clear and apparently almost absolutely pure, and the structure of the crib could be clearly seen for many feet below the surface.

Sediment from the water supply collected at this time was composed very largely of diatomaceæ—an occasional fresh water crustacean and other organisms that belong to the flora and fauna of the northern lakes.

From many hundred microscopical examinations of the filtrate from the hydrant water during the past 15 years, I believe this to be the normal condition of the waters of Lake Michigan, and this pure water usually extends for some distance south and west of the lake crib.

On this second visit (August 6th), soon after the heavy rain and wind storm, the appearance of the lake had entirely changed, the water at the crib and for some distance east and north being quite roiley, having a whitish or milky appearance, with a slight greyish tinge, fading out as we passed the crib and growing darker as we neared the river on our return, and the water of the river was black and very offensive. The milky appearance is undoubtedly caused by the wash of clay from the clay bluffs north of the city, and from the bed of the lake, and cannot be regarded as in any sense objectionable, and certainly cannot be remedied at present.

The "slight greyish tinge" was somewhat suspicious, but as we were not prepared to collect samples of the water, there was only a suspicion of river water as far out as the lake crib. This vital question I have attempted to solve so far as it could be done by a careful microscopical examination. Two days later, on the evening of August 8th, Dr. W. H. Forwood, Surgeon U. S. A., on Gen. Schofield's staff, and myself, made a collection of sediment or filtrate from the lake water, by tying a perfectly clean and rather loosely woven linen napkin, in the form of a bag, onto the laundry faucet, and letting a full head of water run through it for about twenty minutes. We then carefully washed the mass of material that had collected in the napkin, into a pitcher of water drawn from the same faucet, and poured it into a clear glass quart-bottle. Notwithstanding much of the finer material, sand, clay, etc., would pass through the napkin, it made a thick mass that could not be seen through; and after standing a short time, it covered the bottom of the bottle half an inch or more in thickness. We then made a careful and somewhat thorough microscopical examination of this material, and were fully satisfied that but a very small part of it originated in Lake Michigan. A very few diatoms, and three or four crustaceans were about all of the Lake Michigan organisms, properly so called, that we observed. The great bulk of the material was made up of the debris, of animal and vegetable matter, some of it showing the original structure, but most of it was in dark, or yellowish, stringy, irregular masses, in which were recognized anguillula fluviatilis, rotifers, actinophrys, vorticella, and others of the lowest animal organisms, such as are usually found with decaying animal or vegetable matter. I will not venture to decide from what source this mass of very offensive material was derived, but I will say, that it is always present in the lake water after a spring freshet, or after a continuous and heavy rainfall, such as occurred about the second of this month, when the water of the Desplaines had flushed the filth of the Chicago river into the lake, and it generally remains in the water until a wind storm on the lake drives it away, *and is almost always present when the Fullerton avenue conduit is discharging the waters of the North branch into the lake.* The process of collecting this sediment and making the microscopical examination is very easy, and any gentleman of the Association can with but little trouble satisfy himself as to the correctness of these statements.

From present and previous observations, and a long series of microscopical examinations, I am fully satisfied that our drinking water is quite frequently polluted with the filth from the North branch, through the Fullerton avenue conduit and from the main river, when it is flushed into the lake by the water of the Desplaines, coming through the Ogden-Wentworth ditch. I am further convinced that we can have an abundant and constant supply of pure water without adding one dollar to the present current expenses of the city, by damming the waters of the Desplaines out of the Chicago river, and running the pumping works at Bridgeport to their full capacity, ***and on no account should the Fullerton avenue conduit be allowed to discharge the water from the North branch into the lake***, but constantly from the lake into the river.

These suggestions honestly carried into effect, would, in my opinion, satisfactorily settle the question of the purity of our drinking water, for many years to come.

Respectfully submitted,
B. W. THOMAS.

CHICAGO, August 21st, 1885.

CHEMICAL EXAMINATION OF THE CHICAGO WATER SUPPLY.

CHICAGO, Sept. 11, 1885.

During the last thirteen months I have made over 130 examinations of our lake water as it is supplied to us by the city water works. The purpose of that investigation was to find out what truth there is in some published aspersions on the purity of our staple drink. It has been suggested to me that my conclusions would be of interest to the public; hence, the following report:

It is unquestionable that the Lake Michigan water is, in itself, all we may wish. From an hygienic standpoint, it stands high—very few fresh waters excel it—and it surpasses a great many in regard to purity and wholesomeness. We often get it into our houses in that desirable state; but, unless something is done soon, the word "often" will have to be changed to ***sometimes.***

Not frequently our hydrant water contains a considerably increased proportion of organic matter, which may be called partially oxidized sewage. The chief cause of that fact is the same here as in other similarly situated cities, namely, the neighborhood of an outer harbor, acting as a receptacle for a part of our sewage. That evil grows every year, as our population and business increase.

Contrary to my former belief, sewage, sometimes directly, contaminates our water supply. I have been slow in coming to that conclusion, but the evidence is incontrovertible, that out of 130 samples examined by me, at least fourteen were sewage polluted. On the 28th of August last our hydrants supplied us with an article hardly less foul than the Chicago river water. That was the most disgusting sample that ever came to my notice. It was a mine of putrefaction products and bacteria. Quite often, doctors disagree; but, if there is a point on which hygienists are unanimous, it is the importance of preventing the pollution of drinking water by town sewage; therefore, it is our duty to devise forthwith, the means of improving the quality of our deteriorating water supply.

As was to be expected, our suburbs are not better off than we are. I found sewage in two samples of Hyde Park water, and in the one from the town of Lake pipes—the only three examined by me from these sources.

M. DELAFONTAINE.

WHAT WE DRINK.

[Reprint from the Chicago Times of August 17, 1884.]

TO THE EDITOR:—A full and intelligent discussion of the city water supply, its quality and quantity, is at this time of the utmost importance. It is admitted by all competent authorities that an abundant supply of pure water is one of the necessities of a community at any time, but it is of vital importance when threatened with a deadly epidemic. Sir Robert Rawlinson, in a recent paper in reference to cholera, said: "Water should be used without stint for all sanitary purposes. All that water can remove must be washed away. All matter liable to become putrid must be burned." Dr. Rauch, in his recent report to the state board of health, gives as among the best safeguards against Asiatic cholera, "a pure and sufficient water supply."

And Dr. Koch, on his return to Berlin, after visiting the plague-stricken cities of France, said, in a lecture, that "an improved water supply was the best means of checking the disease." While we have at our doors an unlimited supply of naturally pure water, and our municipal authorities have at their command ample means and machinery for its proper distribution and to protect its purity; it is well known that the water delivered to the families of the city is not pure, and that it is impure to such a degree that many of our citizens will not permit its use as drinking water in their families; but the large mass of consumers are obliged to use what they can get from their faucets. It does not require an expert to discover that our water supply is almost constantly contaminated, and there is hardly a doubt that it is with the filth and rottenness from the North branch of the Chicago river, which our municipal authorities are forcing through the Fullerton avenue conduit into the lake at the rate, it is reported, of sixteen thousand cubic feet per minute. Lake Michigan at this point is comparatively shallow—at one mile out from the North-side Pumping Works being but thirty feet deep; at the lake crib, two miles out, thirty-five feet, and at three miles from shore, or more than one mile beyond the crib, it is less than forty feet deep.

It will not do to say that this

MASS OF FILTH

and corruption that is being discharged into this shallow water,. less than two miles north of the North-side Pumping Works, and only about two and a half miles in a direct line to the inlet to our city water supply, can not reach the crib, for anyone familiar with the sediment from the lake water, before and since the conduit has been at work, knows that it does reach it, and there is no reason to doubt but that this filth, in a dilute form, is given to us and to our families as drinking water. Let anyone that visits Lincoln park go to the shore of the lake at the outlet of the conduit, and black patches of this putridity can at almost any time be seen all around, sometimes extending in almost a direct line toward the crib, at others breaking in a slimy suds on the shore, and at all times smelling to heaven against the authors of such a nuisance.

As showing independent of microscopical examination that there is every reason to believe that this poison does polute our city water supply, I give a few analyses made by Messrs. Blaney and Mariner at the request of the board of public works in 1861, when the board was discussing as to the best place to locate the lake crib These analyses clearly show that as early as 1861, organic matter from the shore extended to over one mile into the lake. The analyses are as follows:

	Organic Matter.	Mineral Matter.	Sulphuric Acid.	Sodium and Potassium.	Chlorine.	Silica.	Lime.	Magnesia.	Peroxide of Iron Alumina, and Phosphates.	Carbonic Acid Combined.
One thousand feet from shore at Circleville....	2.88	10.58	.36	.24	.08	4.15	2.59	.59	.42	2.46
One thousand feet from shore at present pumping works.............	2.07	7.54	.17	.37	.10	1.43	2.57	.73	.02	2.70
One mile from shore at Circleville............	1.72	10.13	.31	.23	.04	4.08	2.34	.63	.13	2.34
One mile from shore at present pumping works.	1.99	8.15	.26	.21	.15	1.79	3.01	.60	.02	2.85
Two miles from shore—or at the lake crib........	1.27	5.96	30	.14	.21	.35	2.48	.68	.08	2.50

Referring to the above, E. S. Chesbrough, Esq., then city engineer, in his official report to the board of public works, said: "These analyses confirm the theories, not only that the water of the lake is the purer, the further you take it from the shore, but the one that the impurities are greater within the city limits, south of the river, than at a much less distance north." In this test of their own seeking, and made under its own direction, it was demonstrated to and admitted by the engineer department, that the comparatively small amount of impurity, even at that early day, discharged into the lake, had already extended to over one mile from the shore, and that the general current of the lake carried these impurities mainly from the north to the south. But our present authorities reverse the original design of the conduit and discharge the contents of the North branch into the shallow water of the lake, just north of the inlet to the city water supply. As these impurities are largely

HELD IN SOLUTION

filtering is of but little value. It is like perfuming sewer-gas. It may make it a little less offensive, but it is just as deadly. Water once polluted can not, by any ordinary filtering, be made potable. If anyone thinks that the ordinary filter will remove anything held in solution, or even much of finer organic matter, let him put a little common salt, or laundry bluing, into the upper end of the filter, screw it into the faucet, and try a glass of water drawn through it. Then put into the filter a little starch, or even blood, and try it in the same way, and he will decide that it would be far better to have kept the water pure in the first place. And what is the reason or necessity for pumping from the North branch into the lake? The Fullerton avenue conduit is on the extreme north line of the city, and the North branch and its branches extend through and drain a large area of country, as far north as Highland Park and Libertyville, and at times the branch has a strong current, and it would seem but reasonable to suppose that if the conduit would aid this current, as originally intended, by adding to its volume 16,000 feet per minute, of pure lake water, it would be much more effective in purifying that branch than the present method of reducing this natural flow, which not only poisons the city water supply, but, it seems almost certain, prevents the natural purification of the North branch. If the conduit would discharge its 16,000 feet per minute of lake water into the North branch, and the Bridgeport pumps will continue to discharge (as now reported) 60,000 feet per minute from the river into the canal (I understand that the capacity of these pumps is 60,000 cubic feet per minute), and the water from the Aux Plaines river be kept out of Chicago river, the complaint of unwholesome water would at once cease, and we would be much better prepared to fight cholera and enjoy life than we are at present. Mr. Chesborough, in the second annual report of the board of public works, referring to the bad condition of the river, said: "It appears that the greatest portion of the impurities which give rise to putrid effluvia enter into the North branch;" and it must be borne in mind that not a single sewer enters into that part of the river. And in the same report he recommends, for cleaning the river, "the making of canals from the lake to the North and South branches, and driving water enough through them from the lake to keep the river and its branches comparatively pure at all times." But suppose (not by any means admitting) that pumping from the lake into the river has failed to accomplish what was intended, and that the discharge from the North branch into the lake does keep that branch somewhat less offensive, would it not be economy and common sense to direct the health department to summarily suppress the nuisances on the North branch (which are the cause of most of the trouble), and do what that department has full power to do, and ought to have done years ago, prevent the discharge of filth into the North branch? It would seem that

THE CITY AUTHORITIES,

for the accommodation of a few interested parties, are willing not only to tax our citizens to build a conduit and run pumping-works for their benefit, but to directly poison the water supply of the whole city. Many thousands of microscopical examinations of the filtrate from the water supply and from the North and South branches during the past eighteen years, before the lake water was polluted by the rottenness of the North branch as well as since, have fully satisfied the writer that, with an occasional exception of a few days in the spring of the year, more than seven-eighths of the impurities of the lake water are derived directly from the North branch through the Fullerton avenue conduit.

Second only in quality is quantity. The first and principal object of water-works in a city is to give to our families a full and constant supply of pure water for all household and sanitary purposes, and it should be furnished to this class of consumers in constant and liberal supply and at the lowest possible cost. Secondly, the fire department. After these wants are fully supplied, and not until then, should water be supplied by the city for any other purposes whatever. But apparently our city authorities have heretofore, to a considerable extent, reversed this order, and the steam pumps all over the city have been taking such vast quantities of water from the street mains with which to run elevators, distilleries, breweries, glucose works, etc., that thousands of families, especially those living on second and third floors in apartment and other buildings, have for weeks at a time been unable, from morning until evening, to get from their faucets one drop of water to quench their thirst or cleanse a closet; and these families are obliged to pay high water rates, whether they get any water or not. We are now promised a better supply, and it is earnestly hoped, and the welfare of the city demands that this promise be truthfully kept, and that its purity be restored and protected.

Yours truly,
B. W. THOMAS.

The following letters were received by Mr. B. W. Thomas, concerning the foregoing, and handed to the committee for publication:

CHICAGO, Aug. 20, 1884.

MY DEAR SIR:—I have read the article in Sunday's Times, of the 17th inst. I think the paper is *very* timely, and I have no doubt of the correctness of its statements. It is certainly true, that pumping from the North Branch into the lake is little less than madness.

I will write something to the Tribune, in course of a day or two, supplementing and endorsing your paper, and I shall be glad to help "stir up", the water question, in any way I can. We ought to have the best, the most abundant, the purest, and the cheapest water supply of any great city in the world.

Yours truly,
I. N. DANFORTH.

CHICAGO, Aug. 27, 1884.

B. W. THOMAS, ESQ.:

MY DEAR SIR:—Your "clipping" from the "Chicago Times" at hand to-day. I have just returned from Wisconsin. I most heartily endorse your views as to "what we drink," and am satisfied that you have not in any way overdrawn or over-estimated either the facts or the apparently threatening danger. In my judgment, as expressed in the daily press, three or four years ago, the Fullerton avenue conduit and the Bridgeport pumping works, both are hopeless failures as to the purpose for which they were constructed; neither the one or the other are of any benefit whatever, more than other improvements that are looked upon as monuments of engineering skill.

Yours truly,
T. D. WILLIAMS.

CHICAGO, Aug. 22, 1884.

MY DEAR SIR:—I have carefully read your article published in Sunday's Times, 17th inst., and heartily subscribe to every word of it. Thousands and thousands of lives will be sacrified in this city, from the causes to which you refer, before one of the only things is done which will remedy the difficulty, and perhaps not till some terrible epidemic sweeps over the city, will the authorities wake up to the dangers. The plan you promise as a remedy would improve if quite not obviate the danger, at least for the present; but I am of the opinion that sooner or later the city will be obliged to do what it should have done twenty years ago, namely: bring the water for city consumption from fifteen miles at least, north beyond any possible chance of contamination for all time.

Very sincerely yours,
CHAS. W. PURDY.

CHICAGO, Aug. 25th, 1884.

B. W. THOMAS, ESQ.:

DEAR SIR:—Your esteemed favor of the 22d inst., enclosing an article from your pen on our water supply, is at hand. I had previously read the article, when it appeared, and I have taken pleasure in reading it again. In the main, I agree with you. I believe that the Fullerton avenue conduit is more or less contaminating our drinking water, and I am strongly of the opinion that it would be wise to stop its present action in some way. I have examined our water quite frequently during the past ten years, and my tests show that, year by year, it is growing somewhat less pure. I do not, however, believe that the water is at present unwholesome, at least to the degree that it is commonly supposed to be. Its quality, unquestionably, might be improved, and it ought to be; but, yet I do not think that the water has at present nearly reached the danger line, except, possibly, at certain unfavorable times in the year. But the water appears yearly to be growing worse, and the sooner something rational is done with the Fullerton avenue conduit and other contaminators, the better.

Yours respectfully,
WALTER S. HAINES.

CHICAGO, Aug. 22, 1884.

B. W. THOMAS, ESQ.:

DEAR SIR:—I have carefully read your communication to the Sunday Times, regarding the pumping of the water from the North Branch of the Chicago river into the lake. I am in entire accord with the views therein expressed, as to the damage done by it to our water supply. I have always regarded the pollution thus produced as both disgusting and dangerous. That disease and deaths have resulted from it, I have no doubt.

Respectfully,
W. H. BYFORD.